TENTH ANNUAL REPORT

OF THE

Commissioner of Highways

Ontario

1905

Part V.—Town Streets

PRINTED BY ORDER OF

THE LEGISLATIVE ASSEMBLY OF ONTARIO

TORONTO:
Printed by L. K. CAMERON, Printer to the King's Most Excellent Majesty
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Part I.—County road systems.

Part II.—Township road management.

Part III.—Bridge construction.

Part IV.—Road construction.

Part V.—Town streets.

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HON. J. O. REAUME,
Minister of Public Works, Ontario.

SIR,—I have the honour to submit to you Part V of the annual report of the Highways Branch for the year 1905, with reference to town streets.

I have the honour to be,

Sir,

Your obedient servant,

A. W. CAMPBELL,
Commissioner of Highways.

MUNICIPAL IMPROVEMENT.

A town's streets should be the public lawns, the public parks. They should be to the corporation as a whole what the grass plot in front of the house is to the individual resident. There is no higher evidence of the taste and refinement, enterprise and intelligence of a community, than well-paved streets, bordered with fine boulevards and handsome shade trees. Ill-kept, badly laid out streets speak of public poverty and narrowness, an utter absence of that spirit, which should possess every citizen loyal to his town's interests, and wisely attentive to his own. Public streets substantially paved and boulevarded will in turn encourage a similar treatment of the private property adjoining them. There is no departure which would so instil patriotism and love of home and country as the perfecting of our streets and highways. As a strictly business proposition, street improvement gives good returns to all owners of property; for property values will be found to make a decided advance on all properly improved streets.

That in many towns the work of street improvement is practically untouched is not cause for discouragement. Remembering the wonderful

MACADAM ROADWAY, WITH CONCRETE WALKS AND CURBING.

masonry aqueducts leading the purest of spring waters into Rome eighteen hundred years ago, her fountains and baths, pavements and sewers, it is natural to suppose that the great municipal services of to-day in the older European cities at least, are of long standing. Such, however, is not the case, and the important works of this description, in the majority of instances, are of recent creation. To-day the rural roads of England are unsurpassed in the world, while a century ago they were in an incredibly wretched condition. In the seventeenth and eighteenth centuries, rough, open drains were constructed on the streets of London to receive surface water, and these, in time, became open sewers into which all filth was discharged. It was not until 1847 that the drainage of the metropolis of the British

Empire had so improved that it was made compulsory to empty all sewage into underground sewers. It is of a recent period only that steam power has been applicable to water supply, and it is since that time the important waterworks systems have been developed. The greater part of the present day systems of paving city streets have been developed since 1880. The improvement which has been made in London by the Metropolitan Public Gardens Association in successfully carrying through several hundred undertakings, chiefly the creation of parks, gardens, squares and open spaces, during the last twenty years, is an indication of the modern growth of interest in affairs municipal.

There is a tendency on the part of citizens to suppose that such matters must be left to the municipal council. A striking feature with regard to the origin of these works in England, in Germany, in the United States, is that they are rarely to be attributed to either government or council, but that they owe their creation largely to private citizens, and to associations organized for the purpose of promoting the general welfare.

The Metropolitan Public Gardens Association, of London, England, has been referred to, and this is probably the greatest municipal improvement association in the world. The Commons Preservation Society, the open spaces branch of the Kyrle Society, have been active throughout England, while there are many, very many, independent local organizations working in the different cities and towns. Germany has been termed one vast municipal improvement association, so numerous are the organizations for this purpose. Rich and poor, nobles and commoners, business men and men of leisure, both in England and Germany, are united in their desire to make their native lands more habitable and more beautiful, a patriotism of the truest order.

Much that has been said of England and Germany is applicable to Italy, Belgium, Austria and other European countries. Coming to the United States, we find hundreds of similar organizations, "Village Improvement Associations," "Municipal Improvement Associations," "Municipal Art Associations," being among the more common names by which they are known.

Working in harmony with councils, these associations are productive of much good in all municipalities, small and great. In the United States, the fundamental idea of these societies, in the smaller places, has been to "clean up." Public streets, private lawns, back yards, are all objects of reform. This accomplished, the creation of parks, open spaces, tree-planting, waterworks, and street lighting systems are all objects of attention. A plan of the Hamilton Municipal Improvement Association has been to offer prizes for the most carefully kept lawns and front gardens, and for the best floral window decorations on certain of the principal residential streets. Boards of Trade in a number of towns throughout the Province have been active in municipal affairs, The co-operation of all these efforts with those of councils is most salutary in many ways, not the least being the encouragement of a general interest and an intelligent understanding of local requirements and possibilities. "To make the world a pleasanter place than we find it" is a laudable ambition, finding expression through these channels. There is a wide field for "Village Improvement Associations" in this respect.

Municipal improvement associations are not at all so numerous here as in many parts of the United States and Europe, while the work to be performed is quite as great. There are various branches of municipal work which these societies can consistently foster. The establishment of parks and their proper treatment, the construction of pavements and sidewalks, the care of boulevards and lawns, the encouragement of tree planting, one or all provide scope for the labors of improvement associations.

To this may be added many minor matters suggested by the conditions found in the majority of municipalities. Cattle are running at large in many cases, unsightly and dilapidated fences exist, brush and litter is piled up in offensive heaps, garbage is not properly disposed of by many citizens. Associations need not, however, aim at remedying all these ills if not deemed advisable, but may confine their efforts to one object alone. There may be park improvement or street improvement, lawn improvement or tree planting, sanitary improvement or road construction, as opposed to the more general municipal improvement.

It should be the aim of these societies to foster a right understanding as to the meaning of a municipal corporation. A municipal corporation is merely a society organized for the purpose of carrying on certain institutions and constructing certain works, in a more economical manner than would be possible for the individual member. In Ontario it had its origin when the pioneer settler united with his neighbor to make a common road through the forest. As the community increased in numbers, and in other respects became more complex, there was a more complete organization, and out of this by universal consent the municipality grew.

Municipal organization is a means of uniting the energies of a community in obtaining certain common necessities. It is better that the individual citizen should economize in his private expenditure rather than that he should be deprived of the benefits to be obtained by a union in which is strength. An abundant supply of pure water, good sewerage and drainage, well constructed roads and sidewalks, sufficiently lighted streets, well kept boule-

MACADAM ROADWAY WITHOUT CURBING.

vards. fire protection, obtained in a large way on the club principle, are a measure of economy in spite of the unpopularity into which the means of obtaining them, taxation, has fallen. Municipal improvements make a village, town or city more attractive and habitable; they raise the value of property, they are an evidence of refinement, at the same time increasing it, encouraging thrift and good taste on the part of the individual citizen. But all this should not be left to the councils. It is for the councils to carry out the will of the people, but the people should find out and express what their wishes are.

STREET IMPROVEMENT.

In street improvement will be found a field upon which all can unite, councils, citizens, boards of trade, and improvement associations, in seeking municipal progress.

Town streets, village streets, city streets, and country roads, are in their improvement all subject to the same general principles, but in matters of detail and type of construction there are distinctions which at once suggest themselves, based very largely on the amount and nature of traffic, class of street, and the expenditure that can be made on them. Every street is, in certain respects, a problem in itself, and no general formula can be applied to all, except at a disadvantage.

In general, streets naturally divide themselves into two classes—business streets and residential streets—but, for closer consideration in regard to pavements and street design, the following subdivision will usually apply:

(1) Business streets.
(2) Residential streets which are also main thoroughfares.
(3) Residential streets on which there is little travel.
(4) Streets of little importance either for residence or traffic.

The first of these, streets in the business section, require special treatment as to width of road, kind and strength of pavement to accommodate frequent and heavy traffic, horses and vehicles standing for a length of time, all occupying considerable space. For business streets an easily cleaned pavement is desirable, extending from sidewalk to sidewalk, the latter being immediately in front of the office and shop doors and windows. For business streets in cities and large towns, sheet asphalt, asphalt block and vitrified brick are most commonly employed. In the smaller towns and villages a substantial form of broken stone roadway is desirable.

The second class of street, of a residential character, on which there is considerable through travel to the centre of the town, to a railway station, mill or factory, or from the surrounding country, requires a substantial form of roadway, but which need not be so wide as in the business section. A well-built macadam roadway is advisable in the great majority of towns for such a street, while cities may select a better class of pavement.

The third class of street may be treated in a similar manner to the previous one, but less strength is required to sustain heavy traffic, and the roadway need not be so wide. Appearance is of more importance than strength. A gravel or broken stone roadway is very serviceable for most towns.

The fourth class of street needs only a light roadway, but, as with every street, neatness and cleanliness should be sought after. If in a town or village where the available expenditure is small, such streets should at least be nicely graded, and the sides of the street properly levelled and sodded.

The main distinction in the treatment of business and residential streets is that with the former the pavement, including sidewalk, curbs and roadway, should extend over the entire street allowance. In the case of residence streets a narrow roadway only is required, the sidewalk need not be so wide, a curb may or may not be used, while the remaining space should be sodded, with a row of trees either between the sidewalk and the roadway, or between the sidewalk and the fence.

Macadam Streets.

A standard roadway in towns and villages for all streets, and for residence streets in cities, is a well-built, well-kept macadam. A macadam drive-

way is in keeping with well-kept boulevards, lawns and shade trees—the characteristics of a residential street. It has a cool appearance, the dust can readily be kept down by sprinkling, and, for light driving, it is the favorite among horsemen. A comparison of macadam with asphalt or vitrified brick, in point of utility and appearance, will not result unfavorably to the former for use on residential streets. It is not to be inferred, however, that broken stone roadways are always suitable for streets in the immediate business section, where a harder, and, in a sense, a cleaner, surface is desirable.

By proper attention to repairs the life of this class of pavement can be made continuous. The surface can be frequently rolled, improving it greatly.

A Street in Rosedale.

It should be scraped and swept as are other pavements. When it begins to lose shape the surface can be loosened up by means of teeth attached to the roller, a light coating of new metal applied, and then rolled down as well as when new. It is by such means as these that broken stone roadways can be made much more economical and satisfactory than any other for streets generally. This ease of renewal and repair is a property peculiar to macadam, which renders it most satisfactory for general purposes. It forms a permanent basis, and its perpetuation is merely a matter of repair, to be met by the general funds.

Street Design.

On residence streets it was formerly customary to lay plank sidewalks immediately beside the fence. Outside of this a row of trees was planted, outside the trees was an open drain, and, in the centre of the allowance the roadway for vehicles.

The more modern practice is to remove the sidewalk from its old position and place it outside the row of trees; high board and other disfiguring

styles of fences are removed, and the boulevard, where the sidewalk has been, is, in effect, added to the lawn.

The present tendency is to narrow the width of the driveway. It is found that, to occupy a sixty-six foot street allowance with a four foot walk on each side, and to devote the remainder to the driveway, is a needless expense, both in first cost of construction and in maintenance. From 22 to 26 feet is, on the majority of residential streets of towns, ample to accommodate traffic. A broad driveway is very handsome, but so also are broad stretches of boulevard, nicely ornamented with shade trees. The narrow roadways give vehicles ample room to pass one another, while, to turn, it is always convenient for them to go to a street intersection, where there is sufficient space.

Earthwork.

At present we ordinarily find, on unimproved streets, a row of shade trees outside the sidewalk, the latter being close to the fence. Outside the trees is a deep, open ditch, and between the ditches is a roadway forty feet or so in width. In commencing the construction of the street, it is often advisable to take up the sidewalks to permit a proper grading of the road allowance. If permanent concrete walks have been laid, this will not be possible, and the grade of the roadway, boulevards and walks will have to conform to one another as nearly as possible, consistent with good surface drainage. The engineer should first take the levels of the street, to determine the amount of cut and fill necessary in properly grading the street, and in making a sufficient excavation to receive the road metal. Care should be taken to equalize cuts and fills as much as possible and to utilize all surplus earth in filling up low lots or boulevards on the street. In this, the handling of a considerable amount of earth is often necessary to obtain the best results.

Street Drainage.

The drainage of streets is one of the first matters to which attention should be given, whether it is intended merely to provide a nicely graded earth roadway, or a macadam or other form of permanent pavement. The streets should be given constant grades from point to point, cutting down knolls and levelling depressions, so that the surface water will drain away naturally. While the natural slopes must be the main guide in this matter, yet it is commonly arranged that any change of grade will be made at street intersections.

The surface water should be drained away along the edges of the roadway and given frequent outlets into the sewers or into natural water courses. The sub-soil should be dried by porous field tile drains. The extent of tile drainage required will be controlled by the nature of the soil and the amount of sub-soil water.

Good pavements are largely a matter of good drainage. Not that the shape of the roadway, the material of which the surface is composed, or the way in which it is laid, are unimportant—but that these are very largely a part of a system of drainage. Under-drainage is one of the first points to consider. It is the native soil which must really support the weight of traffic, no matter what material is used to form the surface. Gravel, stone, brick or asphalt are not sufficiently strong to bridge over a wet and yielding sub-soil. If this natural soil is kept in a dry state it can support any weight,

and to this end, underdrainage is necessary. Underdrains may be made of common field tile, four inches in diameter, placed on each side of the carriageway, underneath the gutters at a depth of about three feet. This "lowers the water line" and secures a good foundation.

There must be surface drainage, and for this, the surface must be crowned, or rounded up, covered with a hard surface metal, and open gutters provided to carry away this surface water. The surface metal (gravel or other material) resists wear so that the surface of the road remains smooth, permitting the water to flow readily to the side of the road. But a further object to be

MACADAMIZED RESIDENCE STREET WITH STONE CURBING.

attained by the surface covering, is to have a coating that will not allow water to pass through to the natural soil beneath. By crowning the surface, rolling it to make it compact and smooth, water is at once shed to the open gutters at the sides of the roadway.

Gutters and underdrains are useless, unless outlets are provided, and care must be taken to see that these do not become obstructed. Surface drains may have outlets into the tile drains through catch basins, or into the sewers, if capacity for storm water has been provided. Generally, the angle between the curb and surface of the roadway will form a sufficient gutter, but with macadamized business streets, where horses frequently stand at the edge of the road, the gutter should be concaved and paved with cobble-stones.

Springs underneath roadways should be tapped with blind drains at the source, and the water carried diagonally across the road to the underdrains at the sides.

Road Metal.

In most localities throughout the Province, good road material will be found within easy distance. There will be a choice of granites, gneisses, limestones, sandstones, field boulders, pit and creek gravels. In some districts, trap rock, the best of roadmaking material, is available. The gneisses are usually harder and tougher than limestone, but the latter offsets this largely, by better cementing qualities. Fieldstone makes a very good metal if care is taken in its selection. Pit gravel usually needs screening and crushing to remove sand and earthly matter, and to reduce the large stones

to suitable dimensions. Creek gravel is often sufficiently clean to be applied directly to the road, but attention should be given to breaking large stones. In choosing material, a selection must usually be made between a cheaper and poorer metal in the immediate vicinity, and an expensive but more durable metal from a distance.

Cleanness of material is absolutely necessary. Sand and earth are very injurious to the roadway when mixed with gravel, as they attract and retain moisture and permit it to pass through to the sub-soil. A covering of this kind is not only less serviceable while it lasts, but is less durable than one composed of clean metal. Gravel should be placed on the road in layers of not more than four inches in depth, and each layer consolidated with a roller. The depth of gravel required on the street varies in proportion to the amount of traffic. On residential streets, little travelled, eight inches, at the centre and five at the sides will be sufficient. Residential streets, considerably travelled, with occasional heavy loads, will require nine inches at the centre and six inches at the sides. On other streets, largely travelled, ten inches at the centre and seven at the sides will be needed.

Stone should be crushed and screened into sizes varying from one inch in diameter to two and one-half inches in diameter. The largest stone should be placed in the bottom of the roadbed, and the smallest at the top. A road surface of a mixture of large and small stones, in time becomes very rough owing to the smaller wearing more rapidly than the larger, while the large stones at the surface have a tendency to become loose.

Broken stone should be placed on the roadbed in layers, and each layer thoroughly consolidated with a roller before the next is applied. The depth of the stone may vary according to traffic, from eight inches at the centre with five inches at the sides, to twelve inches at the centre with nine inches at the sides. As with gravel, it is very important that the material should be clean. No 'binder' is needed with limestone. If an exceedingly hard metal such as trap is used, the fine screenings of the stone will be the best aid to consolidation. In rolling, the lower courses of the stone may be dry, but in finishing the road, water should be used to flush a dressing of stone screenings into the interstices.

Machinery for Town Streets.

A proper equipment of machinery and tools is very necessary for the efficient and economical treatment of town streets. The use of machinery, rollers, graders, and stone crushers, has been discussed at length in connection with country roads, much of which is applicable to town streets and need not be repeated.

The most generally useful and necessary implement for macadam street construction is a heavy road roller. A horse roller will be sufficient for the smaller municipalities, but for the larger towns and cities, a steam roller should be purchased.

A roller at once consolidates the broken stone or gravel into a firm, durable crust, such as will support heavy traffic. It is the only means of giving the metalled roadbed a well-shaped, smooth, and properly finished surface, such as will not be rutted and roughened by vehicles.

For economical, durable and serviceable roadmaking a heavy roller is indispensable. A road should be sufficiently smooth and compact to shed the water readily to the side gutters. If the gravel or other road metal is dropped from a waggon loosely on a soft earth foundation, water passes into the sub-soil as through a sieve. Wheels passing over the road when in

such a condition at once sink into and rut not only the gravel, but the earth beneath. Water is held in the ruts, and each succeeding vehicle renders their condition worse. The road is less durable, since the gravel, being mixed with the earth from beneath it, contains, when finally consolidated, a dusty, easily-worn surface.

The weight of the roller must depend upon varying circumstances—the amount of work it will be required to do, the quality of road metal used, the strength of the bridges and culverts over which it must pass. A steam roller costs much more than a horse roller, but does so much better and faster work that it is more economical. A weight of twelve tons does satisfactory work, and it is not too heavy for the majority of bridges. Rolling should commence at the side of the road, approaching the centre gradually. If the roller is first passed over the centre the loose metal is crowded out, and the shape of the road injured. The earth foundation should be rolled, and each succeeding layer up to the top dressing. When the latter is put on, the rolling should be continued in wet weather (or the metal thoroughly soaked from a hydrant or with an ordinary watering cart) until the road is thoroughly compact and solid, able to resist without displacement the heaviest load passing over it.

Horse rollers, weighing five tons (but which may be loaded to eight tons), cost about $90 per ton. Several towns which at first purchased horse rollers, have exchanged them for steam rollers. The steam rollers now owned by municipal corporations in Ontario are shown in the following schedule:

Municipality.	Year Purchased.	Weight (tons).	Cost.
Bellville	1898	15	$3,000
Berlin	1898	15	3,100
Brantford	1901	15	3,200
Brockville	1894	17	4,000
Carleton Place	1901	10	3,000
Chatham	1898	12	3,135
Cornwall	1898	16	3,000
Galt	1896	15	2,700
Guelph	1902	15	3,250
Hamilton	1898	15	3,300
	1900	16	3,250
Ingersoll	1898	12	2,900
Kingston	1884	18	
Lindsay	1903	15	3,250
London	1895	15	3,000
Niagara Falls	1897	12	3,650
Niagara Falls Park Commission	1903	7	2,300
Orillia	1904	15	3,000
Ottawa	1885	15	3,000
Owen Sound	1898	15	3,000
Pembroke	1902	15	3,250
Peterborough	1899	15	2,800
Renfrew	1899	15	875
St. Catharines	1897	12	3,600
St. Thomas	1900	12	2,900
Smith's Falls	1900	17	3,100
Stratford	1897	15	3,800

Municipality.	Year Purchased.	Weight (tons).	Cost.
Toronto	1895	15	3,050
	1900	10	2,373
Welland	1903		3,000
Windsor	1898	12	2,800
Woodstock	1897	10	3,300

Rock crushers are used for preparing, for street purposes, not only quarried stone, but also field boulders and coarse gravel. By a screen attachment the product is separated into grades for application to the roads in the best possible manner. For city or town work, where a large quantity of material is required, it is a mistake to purchase a small crusher. The breaking of stones is a very severe test of machinery owing to the varying character of the material; and ample capacity, so that the work can be done with perfect ease, is necessary. A crusher which can break ten cubic yards per hour at three-quarters its capacity, is the most serviceable and economical machine for most towns and cities. The extra cost incurred will prove a

A Park Roadway.

profitable outlay when the expense of maintenance and operation is considered.

Grading machines are exceedingly useful on town and village streets. They simplify the work of grading roadways preparatory to placing gravel or broken stone. They are especially valuable in grading and keeping in repair streets which are not macadamized or gravelled. By their use the streets of every village can be nicely graded at little expense, and even earth roadways kept in a presentable condition.

Cleaning Macadam.

A great need of macadam streets, especially in a business section, is that they be regularly cleaned. In Galt, Orillia, and other towns, a man is kept steadily at work with a broom and wheelbarrow. By this means their main streets are kept in very good condition.

It is a mistake to provide for the construction of good pavements, without at the same time insuring the investment by providing for their proper care and maintenance. If an asphalt pavement is allowed to go uncared for, in a very short time an accumulation of dirt, brought on by traffic and other means, will make it discreditable. But where these high-class pave-

ments are laid, provision is always made for scraping, sweeping and sprinkling, so that their best qualities are always fully realized. The cheaper class of pavements, such as macadam and gravel, are generally neglected, and in consequence, wrongly condemned. Quite as much, often more, filth from outside sources is carried to a macadam or gravel roadway than to asphalt; and to realize the most from the investment, similar attention should be given. During the summer season these streets should be swept with a revolving sweeper. In the spring and fall, gutters and catch-baisins should be scraped and cleaned. During the dry season, sprinkling will lay the dust and lessen the wear.

The purchase of certain road implements, more especially sweepers and scrapers, is sometimes opposed in a town, on the ground that they will take away the employment of a number of old men, largely dependent upon corporation work for support. Experience with these machines, on the other hand, goes to prove that they do not take away work, but in some cases tend to create work. They enable a much greater amount of street to be gone over, and effect a most encouraging improvement. The material swept or scraped to the side of the street has still to be drawn by hand into heaps, and thrown into wagons; gutters have to be cleaned out, and weeds have to be cut. The work of these machines in cleaning the streets stimulates to greater effort on the part of the ratepayers, and there is a tendency to extend the work rather than to decrease it.

BUSINESS STREETS.

Macadam roadways are very satisfactory for residence streets, and are largely used for business sections. In Peterborough, Brockville, Galt, Orillia, Barrie, Acton, Berlin, Carleton Place, Cornwall, Ingersoll, Pembroke, Renfrew and other towns, the main streets are macadamized, and, by proper attention, this pavement is found fairly satisfactory, and a vast improvement on what ordinarily prevails. In the main business section, however, it is desirable to have a pavement that can be kept clean at all seasons, and which can be crossed at any point, rather than at street intersections only. Macadam does not fully meet these requirements. Horses standing at the sidewalks tear up broken stone, leaving a succession of holes, and where there is much heavy traffic, it is difficult to keep any part of the roadway in good shape. For this reason, in the business district, a better class of pavement is of great advantage, and in the larger towns is almost a necessity. With present practice, practically the only two materials available for smaller municipalities in addition to ordinary and tar macadams, are vitrified brick and asphalt block. To this may be added sheet asphalt for large cities, but unfortunately the methods of construction and repair are not such that it can be economically used in small municipalities where only a short pavement is required.

Vitrified Brick.

Vitrified brick has been used in Ontario for a number of years, and has been found a very satisfactory paving material for business sections. Roadways of this material have been in use in Toronto for over ten years under fairly constant and heavy traffic and are found exceedingly durable, requiring very little repair. A pavement of vitrified brick one mile in length on the main business thoroughfare of St. Thomas, laid in 1899, is giving good

service. The chief defect is that it is noisy under traffic, and while this is very objectionable on residence streets, on business streets it is much less noticeable.

Vitrified bricks are different in composition and manufacture from the ordinary building brick. They are made from clay or shale, or a mixture of the two, which is heated to the point of vitrification and then slowly and gradually cooled. The size of each brick is usually about $2\frac{1}{2} \times 4 \times 8\frac{1}{2}$ inches, or $3 \times 4 \times 9$ inches. The durability is not equal to that of asphalt or stone blocks, but they are less noisy than stone blocks. They are manufactured in Toronto, in the States of Ohio, New York and Pennsylvania, and elsewhere. There is room for much variation in the quality of brick. The process of manufacture is one which requires an expensive plant and much skill in burning. In laying a vitrified brick pavement. the natural earth is first prepared by draining, grading and rolling with a steam roller. On this a layer of concrete or broken stone is laid, from four to six inches in thickness. On this is spread a layer of sand about one inch in thickness, and in this the bricks are imbedded. They are laid on edge, in courses, at right angles to the street line, and with broken joints, the joints being cemented or "grouted."

Asphalt Pavements.

Asphalt is a mineral bitumen, a material similar to tar, and is closely allied to petroleum. Deposits of this material have been found in the County of Lambton, but they are too small to be of commercial value. One of the chief sources is the Island of Trinidad, and it is found in the Island of Cuba and elsewhere. The crude asphalt, as found in its natural state, is refined for use in paving, and is used merely as a cement to mix with sand or finely crushed stone. Pavements are made also from "rock asphalt," a variety of limestone or sandstone, impregnated with bitumen. The rock is ground to a powder and is then used in paving without other material being mixed with it. Rock asphalt, or natural asphalt, as it is sometimes termed, is found in the southern states, and is also used largely in Europe.

Sheet asphalt is the form in which it is most commonly used. It is one of the most desirable paving materials now in use, but it is difficult to lay and to keep in repair, requiring skilled workmen and an expensive plant. For this reason sheet asphalt is not suitable for the average town or even small city, where it is too expensive for use except for short sections in the business centre.

The appearance is exceedingly good, and, if properly laid, it is very durable. It consists in the main of a concrete base from four to eight inches in thickness, over which is laid a two-inch layer of asphaltic mixture; that is, a composition of sand or stone dust and asphalt thoroughly intermixed, in about the proportion of 90 per cent. sand and 10 per cent. of asphalt. This crude asphalt is refined, mixed with sand and stone dust, is heated, and a thin coating spread on the road over the concrete base. Rock asphalt is obtained by grinding to powder bituminous limestones and sandstones. This powder is heated and applied to the roadway in a manner similar to the Trinidad mixture. The asphalt forms a tough, rubber-like bond, cementing the sand and stone dust together.

Asphalt blocks differ from sheet asphalt in that they are manufactured into the form of bricks, and can thus be used in small quantities.

Asphalt blocks were first used in San Francisco in 1869, and have since been very largely used in a number of United States cities, particularly

Washington, Baltimore, New York and Detroit. In Ontario they have been used in Windsor, where they were laid on a broken stone foundation, and are proving very satisfactory. They are also being used in Sarnia, Stratford, Chatham and other places.

The block ordinarily used is five inches wide, twelve inches long and three inches deep. A block four inches deep can be obtained if desired. The materials composing the block are combined in a heated state by mechanical mixers, and, passing into a machine similar to that used in pressing bricks, are then moulded under heavy pressure. The composition of the blocks is about as follows:—

	Per cent.
Asphaltic cement	8 to 12
Stone dust	8 to 10
Fine crushed granite	84 to 78

An asphalt block pavement should be laid with a concrete base from four to six inches in thickness; the concrete to be of about seven of gravel to one of Portland cement. On this should be spread a one-half-inch coating of Portland cement mortar (mixed in the proportion of one of cement to three

An Asphalt Pavement with Concrete Sidewalks, Curbs and Gulleys.—Harvard Ave., Parkdale.

of sand) in which to imbed the block. The block, when laid, should be grouted with neat cement.

While not so noiseless as sheet asphalt, asphalt blocks are not so noisy as vitrified brick. The advantages claimed for this pavement over sheet asphalt are:—

(1) That it is less slippery and affords a much better foothold to horses.

(2) That it can be used on steeper grades.

(3) That it can be used in small cities where there is no asphalt plant.

(4) That it can be laid and prepared without special appliances or skilled labor, and

(5) That it is more durable than sheet asphalt, does not crack in the same manner and requires less repair.

SEWERAGE.

Sewers are a valuable aid to proper street construction, affording outlets for drainage, and it is of very much importance that they be laid before streets are paved or macadamized. To construct sewers after the streets are paved means the destruction to a great extent of the street improvement.

Private sewer, water and gas connections, and any underground work needed on the street, should, as far as possible, precede the paving or macadamizing of the streets, as the tearing up of roadways in sections is exceedingly destructive.

Sewers become necessary in populous communities as a matter of convenience, and to preserve public health. In designing a system of sewers, the latter object, it is apparent, must take precedence. The duty of sewers is to remove the sewage without delay to a place where it can be disposed of, and a further question to be decided is the means to be employed in disposing of the sewage discharged at the outlet. By sewerage in Canada "drainage systems" are understood and none other need be considered. Small sized sewers, such as are required by most villages and towns up to two feet diameter, are ordinarily made of vitrified clay pipe or tile. Even up to a

AN ASPHALT BLOCK PAVEMENT AND CONCRETE SIDEWALKS.

diameter of forty-two inches tile may be used, but it is considered better practice above two feet to build the sewers of brick or concrete. The size of sewers is a matter for careful calculation, based upon population, area, rainfall, number of factories and similar considerations.

Separate and Combined Systems.

Sewers of the drainage class may be "separate" or "combined."

The comparative merits of the two systems have formed the subject of much discussion among engineers, but the conclusions reached are not favorable to the indiscriminate application of either. Both have desirable qualities more or less adapted to varying conditions, while in some instances a judicious combination of the two systems will be more suitable than either system alone.

With the separate system, two lines of pipe are laid in one trench, one line to the side of and above the other. One line of pipe is intended to receive what may strictly be termed sewage—that is, kitchen slops, the discharge of closets, manufacturing waste waters, drainage of stables, etc. The other line of pipe is intended for storm water—the surface water from streets, gardens and roofs.

The combined system is a single line of pipe only, but of large diameter, intended to receive not merely sewage and cellar drainage, but storm water as well.

The indiscriminate application of either of these systems is not to be entertained, as both have their uses. To advocate unreservedly the separate system is very apt at times to minimize the value of good street drainage. There is apt to be little difference in the cost of the two, as a separate system, though requiring smaller pipe, requires the additional system of drains to receive the storm water. The one material advantage of the separate over the combined system arises when there is necessity for treating the sewage at the outlet by septic tank or otherwise so as to render it harmless, since when diluted with a large amount of rain water, the expense of disposal is increased. There is this to be said, however, that while house sewage may be more dangerous, the street washings which reach the sewers, or drains, are equally offensive and should be purified.

Among the further advantages of the separate system are, that by regular flushing, it can be kept cleaner than the combined system, while the smaller pipe tend to the same result, ventilation is more perfect, cellars are not in danger of being flooded in time of storms by water backing up in them, as is apt to be the case with the combined system.

Advantages of the combined system, among others, are that obstructions can be removed more readily than with the separate system owing to the larger pipe used; grades need not be so steep; so large a quantity of water is not needed for flushing, as this is accomplished by storm water; and the street washings, as foul, if not as dangerous as house sewage, are removed.

The first cost of a separate system may frequently be made less than that of a combined system by omitting storm sewers. When it becomes necessary to lay pipe to carry away storm water, in order to protect the streets and gutters from flooding and from excessive rushes of water, the total cost, as a rule, will be as great as the cost of a combined system in which a much larger pipe is used. The practical difficulty with the separate system in this regard has been that, in spite of the importance of good drainage in street improvement and the need for convenient outlets for storm water, the cost of storm sewers has interfered with their construction. The expense, when added to the cost of street improvement, is likely to operate unfavorably.

Sewers imply a waterworks system to supply water for flushing and cleaning. Separate systems require a greater amount of water than do the combined systems, the latter depending chiefly for cleansing upon storm water. Separate systems, on the other hand, must be regularly flushed, and for this purpose flush tanks holding from 250 to 350 gallons each, which fill and discharge automatically usually twice a day, are placed at the upper ends of the sewers. These tanks empty rapidly, fill the sewer for some distance below, and the sudden rush of water removes solids which have settled in the bottom or collected on the sides of the pipe. Combined sewers are flushed when necessary from manholes to remove occasional obstructions, a stream being carried from the nearest hydrant in fire hose.

Incidental to sewers are the catch-basins, usually covered with an iron grating, which receive the surface water from the street, and the manholes, also covered with an iron grating, which serve the double purpose of venti-

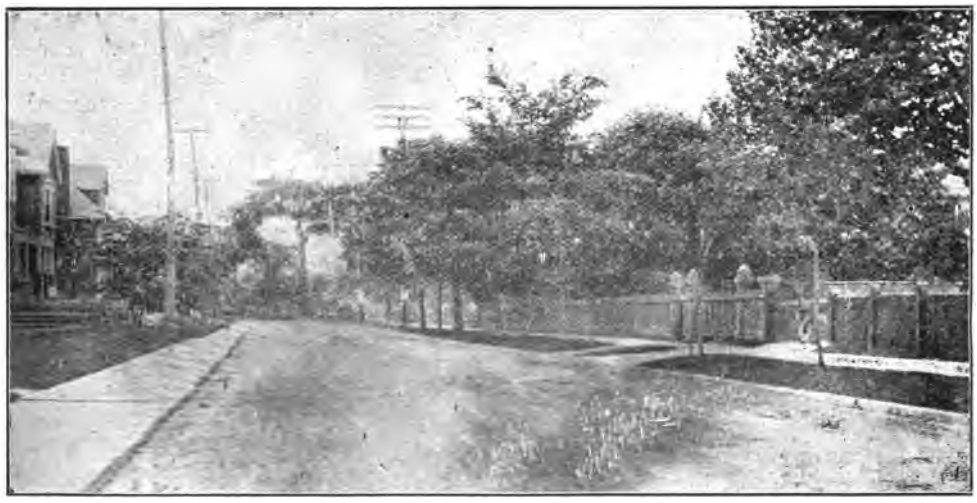
lating the sewers and permitting entrance for the purpose of examination or flushing.

Sewers in towns and villages are generally constructed wholly of salt-glazed vitrified sewer pipe, but as municipalities increase to the dimension of cities, a main trunk sewer of brick is usually required.

The specifications under which sewer pipe are laid require that the pipe shall be well burned, truly circular in bore and of an equal thickness throughout, perfectly sound, free from blisters, cracks, flaws and other defects. Each pipe must be not less than two feet in length. Pipes for private connections are six inches in diameter, with Y junctions. The joints are filled the full length of the socket with braided or twisted gasket, driven in tightly, and the joints made water-tight with Portland cement grout.

Sewer Assessment.

The frontage assessment system adopted with respect to sewers is one which has both simplicity and fairness to commend it. A by-law should usually provide that there shall be a uniform frontage tax levied against all property in front of which a sewer is constructed as a local improvement,



THE SYMMETRY OF THIS STREET IS DESTROYED BY PLACING ONE SIDEWALK BESIDE THE CURB, AND THE OTHER WITH A STRIP OF SOD BETWEEN. GOOD STREET DESIGN IS ESSENTIALLY FORMAL.

and against all property draining into such of the main sewers as are constructed at the city's expense. This amount may be paid in small annual instalments. The cost of any sewer in excess of the total amount assessed in this way may be borne by the general taxes. Special provision should be made for corner and irregularly shaped lots.

This method of assessment equalizes the cost of sewerage throughout the municipality and does not require one street to pay for a sewer deeper and longer than its own needs demand in order to provide drainage for another street—a difficulty met with in the ordinary method of frontage assessment, by which each street pays for the sewer laid in front of it.

CONCRETE SIDEWALKS.

Concrete sidewalks are growing in favor owing to the greater durability and better appearance as contrasted with the increasing price of lumber and the poor quality obtainable. Plank walks are at best short lived, require a great deal of repairing, and, when they begin to wear out, are frequently dangerous. A well-built concrete walk, on the other hand, is practically permanent and does not demand the care that plank walks require.

Without resorting to walks made merely of a bed of gravel or finely crushed stone (laid very much after the manner of the gravel or stone foundation commonly used for concrete walks), it is difficult to find a cheaper walk than concrete. Contracts were let in 1905 for concrete walks at 8½ cents per square foot. This is a very low figure, and is very near the actual cost, but under favorable conditions serviceable walks can be built for that price.

For residential and outlying districts particularly, there has been, in some towns and cities, a tendency to lay concrete walks in a more expensive manner than is necessary. Under suitable conditions, and especially with a dry, sandy sub-soil, light but durable concrete walks can be laid without a gravel or broken stone foundation—merely a 3½-inch concrete base and a one-inch surface coating of cement-sand mortar. Particular care should be given in laying such a walk to provide the best Portland cement, thoroughly mix the concrete, and to completely divide the walk into blocks so that there will be a clear space at each joint. Even on clay soils, if properly drained, such a construction should be safe; or, in any event, a four-inch gravel or stone foundation should be sufficient. A great deal of the failure of concrete walks, commonly attributed to a weak foundation, is really due to poor workmanship, carelessness in mixing the concrete, inferior cement, and other causes. Crushed granite in the wearing surface is needlessly expensive, except for certain walks in the larger cities, subjected to exceptionally heavy traffic.

These walks are variously called "artificial stone," "granolithic," "cement," "concrete," "cement-concrete." The term "granolithic" is properly applied to the walks of this class in which granite chips are mixed with sand and cement in forming the wearing surface. Although of similar appearance, concrete walks are not the same material as is used for asphalt roadways, with which they are very commonly confused, the asphalt pavement being a mixture of sand and mineral pitch. Asphalt is occasionally, as in the City of Kingston, used for sidewalks. Vitrified paving brick are also used to some extent for sidewalks, costing about the same as concrete, while they are commonly used for crossings, being laid on a concrete base, and taking the place of the concrete wearing surface.

The usual requirements for a concrete walk are:—

(1) A foundation layer of stone, gravel, cinders, or other suitable material, consolidated to a depth of from four to twelve inches in thickness, according to the nature of the sub-soil.

(2) A concrete base from three to four inches in thickness.

(3) A surface coating of cement-mortar one inch in thickness, mixed in the proportion of one of cement and three of sand.

The foundation layer is intended to provide a certain amount of drainage, as well as strength, and should be greater on a clay soil, retentive of moisture and subject to upheaval by frost, than it need be on a loose gravel or sand.

A concrete base three inches in thickness is ordinarily required on a favorable soil, and four inches where the sub-soil is of clay, or where, for other reasons, the drainage is not thought sufficient.

Where broken stone is used in the concrete base, safe proportions would be one part of Portland cement, three of sand, and six of broken stone. This quantity of sand and cement will make a strong mortar, and there will be sufficient to surround each stone and fill the voids.

Where gravel is used to form the concrete base, the usual proportions are one part of cement to seven or eight of gravel. The gravel used in mixing concrete should be free from clay, loam, or earthy material, and should contain about thirty per cent. sand. As there is apt to be some uncertainty as to the quality of the gravel and the uniformity with which sand is intermixed with it, a greater proportion of cement is required than with a carefully adjusted mixture of cement, sand and broken stone.

The sand used in mixing broken stone concrete should be clean, sharp, and of varying sized grain. One of the objects to be aimed at in mixing concrete is to have fine and coarse materials in such proportion to one another that the percentage of voids in the consolidated mass will be reduced to a minimum.

For the surface coat the proportion of one of cement to three of sand is customary, except at street crossings, where one part of cement to one and one-half of sand is commonly employed.

As previously pointed out, special care should be taken to thoroughly mix the concrete, and to divide the blocks completely at each joint—this division providing for contraction and expansion. A four-inch slab of well-made cement-concrete is exceedingly strong, and should not crack or disintegrate when laid on the surface of any soil; but if the soil is wet, the walk would have a tendency to become uneven.

Quite apart from the conditions to be expected in frosty weather, concrete sidewalks exhibit at times a tendency to become dangerously slippery; the entire surface in some cases, and in others merely spots. The condition is frequently serious, and is one to be avoided as far as possible. The tendency to be slippery may arise from several causes. Granite chips, or broken stone of almost any kind, used in the surface coating, will wear smoother than an ordinary sand finish. A surface rich in cement generally wears smoother than one in which the proportion of sand is greater. The dusting of the surface on completion with neat cement, instead of a mixture of sand and cement, tends to smoothness. A trowel finish is smoother than a surface finished with a wooden float. Towns in which hills are numerous, and slippery walks, therefore, more necessarily avoided, find most serviceable a plain, sand-cement surface, finished with a wooden float, indented with a toothed roller, or other means of roughening.

When walking on concrete sidewalks, a hollow sound is frequently noticed. This hollow sound indicates a separation of the concrete base and surface coating. The remedy is that ordinarily prescribed in specifications for sidewalks, requiring the surface coating to be put on the base before the latter has set and while still adhesive. That is, the concrete base should be covered with the wearing surface as the work progresses, the former being spread in short sections and immediately surfaced. In this way the two layers of concrete unite to form a solid stone.

The "hollow sound" is the forerunner of the time when the surface will crack and shale away from the concrete base. When, for this reason, it becomes necessary to re-surface a concrete walk, the entire surface, as far as it can be loosened, should be taken off. The concrete base should be thor-

oughly flushed to free it from all loose particles, and made as wet as possible. Dry cement should then be sifted over it and the new surface coating of cement mortar at once applied. This is the usual process for recommencing interrupted concrete work, the surface being well flushed, dusted or grouted with cement, then the new concrete put on. In Part III. of this Report, concrete is discussed in reference to bridges, and the information in that regard will be found largely applicable to sidewalks.

LOCATION OF SIDEWALKS.

Until recently it has been customary on residential streets to place sidewalks along the edge of the street allowance, as close as possible to the fence. Outside the walk was planted a row of treees, and some little distance nearer the centre of the street was placed the curb of the roadway. The more modern plan practised is to remove the sidewalk from the old position near the fence, constructing new walks outside the line of trees. Sometimes the walk is laid immediately next to the curb, and in other cases, a strip of sod is left between the walk and the curb.

There is very general accord of opinion that, in the design of streets, it is better to place the walk outside the row of trees. In this position, the sidewalks are more easily lighted, and the public are further removed from private residences. The appearance of the street can be much improved by removing old fences, and, in effect, the portion of the street up to the sidewalk is added to the lawn. It is objected that citizens often take this view too literally and that they are inclined to claim and use as personal property that part of the street allowance. But even this has its advantages, as citizens inclined to this view are apt to take the more care of the grass and boulevard, thereby tending to improve the appearance of the street. Occasional cases of citizens fencing in and assuming possession of a part of the street can be easily remedied, and once understood, little further difficulty need arise.

On business streets it is, as a rule, essential that the sidewalks be laid as heretofore, close to the edge of the street allowance, in order to permit easy access to stores, offices, and for the display of goods in shop windows. On business streets there are no trees, and the reasons respecting street lighting, privacy and care of boulevards do not arise, as in the case of residential streets.

There is inclined to be a further difference in practice and opinion with regard to the exact location of the sidewalk outside of the trees, some preferring it next to the curb, others preferring a space between the walk and the curb.

In laying permanent concrete walks it is an excellent plan to lay them with a strip of sod between the sidewalk and the road-bed, and this will give the street a much handsomer and more park-like appearance than if the sidewalk is placed close to the road-bed. In the latter case, considerable difficulty will arise in making entrances to alleys and private property, as a depression has to be made in the sidewalk, or else a strip of concrete carried out into the gutter. This arrangement for private entrances is a disfigurement to the street. If the concrete is carried out into the gutter, it is an interruption to surface drainage. If a depression is made in the sidewalk it creates places where users of the walk are apt to slip or trip. If the sidewalk is placed in from the roadway, these difficulties do not arise; the pedestrian

has a little space between him and the horses and vehicles on the street; is less exposed to the dust, and has partial shade. It is a satisfactory compromise between two extremes—the position at the edge of the street allowance, and the position at the edge of the curb.

The cost of constructing a curb detached from the walk may be slightly greater than if the curb is formed as a part of the concrete walk, but the difference is, as a rule, very trifling. The objection has been suggested that property owners may be apt to neglect a narrow strip of grass between the sidewalk and the curb, but this has rarely been the case. The edges of grass may require a little more clipping along the walks when laid away from the curb; but no more than when the walk is laid in the old position along the edge of the street allowance. None of these objections counter-balance the advantages of walks laid a short distance from the curb, in respect to appearance, and entrances to private property.

Where a strip of sod only one foot or so in width between the walk and the curb can be retained, as on a forty-foot street, there may be more reasons for dispensing with it, but even this narrow strip adds to the appearance of the street, and helps in the proper construction of the sidewalk.

Wherever a sidewalk has been laid on one side of the street with a strip of sod between the walk and the curb, uniformity of the street should be preserved by laying the sidewalk on the other side an equal distance from the curb.

CURBING AND GUTTERS.

A curb is a line of plank, flag stone, or concrete placed along the edge of the metalled roadway. It is essential on a business street to finish and protect the sidewalk, but may be ommitted on residential streets and park roads. Curbs are now largely made of concrete, and are frequently so formed as to supply a concrete bottom for the gutter as well. A curb defines the roadway, giving the street a more finished appearance, as well as protecting the boulevard from careless drivers and from horses standing or tied at the side of the street. It also forms the gutter and aids in keeping it clean and free from obstruction to the flow of water from the roadway. A curb, or curb and gutter, should be constructed after the street has been excavated, graded and underdrained, preparatory to laying the first course of the roadway or pavement. Rolling can then be more perfectly performed, as the curb keeps the road metal in place, preventing it from being crowded outward by the weight of the roller. Being carefully laid to grade it is used as a line from which to gauge the finished surface of the pavement.

The process of constructing a concrete curb and gutter is first to excavate to sub-grade and lay the foundation of gravel or other material, which is pounded or rammed until firm and compact. Planks are then put in place to form the core of the curb, and the side of the gutter next the roadway. The coarser grade of concrete is then placed and tamped between these planks, and is ready, after rounding the corners with suitable tools, to apply the surface coat. To do this the inside plank forming the core of the curb is moved outward the required distance, usually one inch, and the cement mortar or finishing coat is then run behind it, in contact with the core, and the remainder of the surface coat is readily applied. Before the surface coat is set, the plank retaining the face of the curb in place is removed, and the whole is shaped with float and trowel. A bristle brush dampened is used last, and, in the hands of an expert, the completed work is given the appearance of natural stone. By means of flat metal plates, which are used as well to keep

the planks a proper distance apart, the curb is separated into desired lengths, usually eight feet, the separation providing for expansion in hot weather. The specifications for curb and gutter are usually a part of or modelled from the sidewalk specifications, the requirements for excavation, foundation, composition and mixing being in all respects similar. The cost will vary with local conditions, cost of cement, etc., but, if laid by a street overseer experienced in laying concrete walks, it would be expected to average thirty cents a lineal foot.

SYSTEM OF STREET MANAGEMENT.

In order that the care of streets may be reduced to a system the great need of the majority of towns at present is: (1) Capable oversight, so that work will be performed under right principles of construction and in accordance with carefully prepared plans. (2) The concentration of funds so that work of a permanent nature can be undertaken.

System, as applied to streets and pavements, is not generally understood, although parallel with the construction of waterworks and sewers. With the

ONE SIDEWALK LAID AT THE CURB AND THE OTHER AT THE FENCE IS NOT IN THE BEST OF TASTE.

construction of a system of waterworks a plan for the whole town is first decided upon. The required size of the pipe on the outlying streets is estimated. Then that of the lines by which these are supplied is computed, and so on until the size of the largest mains is known, and a complete plan showing the size of all pipes required is laid down. The whole of this may not be constructed at one time, but definite provision is made, and it is constructed in accordance with the plan as required. This is the case with waterworks systems, sewerage systems, and should be the method adopted in the construction of roads. The illustration may be extended to include the raising of funds, repair and maintenance; all public work should be carried on in a business-like way, under nearly one system of management. A definite plan for the whole street mileage should be considered, and the means provided for carrying it out as required.

Annual Appropriations.

The majority of towns pay for work on streets by making annual appropriations from the general funds of the municipality. The amount varies greatly with different towns, according to size, wealth, requirements and liberality in this respect, ranging usually from one to ten thousand dollars. This money is distributed over the town in several ways. In some cases it is sub-divided among the wards; the basis of this may be the assessed value of the property in each ward, or it may depend on the skill of the ward representative in wire-pulling. In other cases the ward boundaries are overlooked and the money is divided as the council may deem advisable; in this instance influence is usually brought to bear directly on the council by individual citizens or bodies of citizens.

In whatever form, the final tendency of this method of making expenditure invariably is to scatter the appropriation over the whole street area, not in accordance with the actual improvements needed, but according to a councillor's idea of equity, modified by his desire to retain or gain the support of his constituents. The manner in which the appropriation is spent makes it a sort of legitimate election fund; the people expect it and the council has no other course to pursue. The character of the work done is merely temporary patchwork, an effort to keep in repair mud roads and gravel roads which have never been suitably built. No durable improvements are attempted, and the plans are those belonging to townships, as they are commonly developed by a bad phase of statute labor. While such roads are cheapest in first cost, they are the most expensive to maintain.

The Expenditure.

If the system of making annual appropriations is adhered to, in carrying on street improvement, the disposition of the money should be such that a certain amount of permanent roadway will be built every year, devoting the smallest sum possible to repairing unimproved streets. This, however, is not the business-like policy, the policy on which great improvements have been successfully brought about. One man never attempts to build and pay for a railroad; but a company is formed, bonds are issued, the money obtained to be paid back in the course of a number of years. The work as soon as finished, is an asset to be balanced against the bonded indebtedness. The company which manages and directs the railroad expects it to earn a sufficient revenue to keep itself in repair, and to ultimately pay for itself. This is the method whereby all our greatest and best business concerns have been built up. It is the only method whereby permanent and durable results can be economically obtained. This is the method adopted in establishing municipal waterworks systems, electric light and sewer systems, and is quite as necessary in street improvement. The annual taxes should be used to pay the interest, for maintenance, and to create a sinking fund to meet the principal when due. Improvements made and maintained in this way are not a direct financial loss. But these improvements are an asset to be placed to the credit of the town, to be balanced against the bonded indebtedness just as is the case in the construction of railroads. A town which owns a public hall worth $20,000, as a corporation is none the poorer because it is in debt to this amount for its construction. The hall is an asset which should be placed to the town's credit, balancing the indebtedness.

The principle of paying for a public work immediately on its completion is not a just one. The benefit derived from improved streets, a town hall, a

sewer system has only commenced when the work is completed. This benefit extends over a term of years, and the only fair system is to ask payment from the citizens as the benefit of the work is received by them. Nor is the full benefit of street improvement derived when only short sections of street are constructed annually. It is not until the whole town is provided with well-designed thoroughfares that the full benefit commences. Short sections are merely scattered links of a chain; the usefulness of the chain is not realized until all the sections are joined, to the full length required.

CURVES IMPROVE THE APPEARANCE OF RESIDENTIAL STREETS.

Assessment.

In assessing the cost of these improvements, the annual payments may be met by the general funds of the town, in which case, in order to render justice to all, it would be necessary to raise sufficient money to suitably improve at least the most important streets of the town; or a local improvement by-law may be adopted, this being usually framed on the frontage assessment system.

The latter system, that of frontage assessments, is one of the most suitable remedies for existing conditions. When work is undertaken by means of it, money is raised by the issue of debentures extending over a term of years. The amount is assessed against the property abutting on the work, according to the frontage of the lot. By means of the frontage tax system sufficient money can be raised to do durable, serviceable and economical work, and it is generally the most satisfactory means of consolidating road expenditure. Money thus obtained, may be had at a low rate of interest, and, payment being extended over a term of years, the annual rate of taxation is small. The ultimate cost is no greater than under the old system of patchwork, the difference being that less money is wasted. The durable improvements obtained are at once a benefit to the property owner, the value of the property is increased, and the town, as a whole, becomes a more desirable place of residence.

Town Engineers.

Practically all the cities in the Province have city engineers engaged at a salary of from $1,000 per annum and upwards. Except in the largest cities, these engineers have a private practice in addition to their city work. Their duties are mainly to design and supervise municipal work, and they are usually assisted by a foreman, or foremen, for day work, and an inspector, or inspectors, in the case of contract work. Certain towns—Berlin, Peterborough Brockville, Cornwall, Midland, Owen Sound, Smith's Falls—follow practically the same plan, although in a few cases there is a street commissioner engaged permanently, while the engineer is only employed as occasion requires.

Numerous towns have a street superintendent only, who should be a man of good, practical judgment, with some business and mechanical ability, and able to handle men. Among the towns having street superintendents in this way are:—Barrie, Carleton Place, Collingwood, Dundas, Galt, Ingersoll, North Bay, Orillia, Paris, Renfrew, St. Mary's and Welland.

A good plan for towns desiring such an officer is to advertise for a superintendent or engineer, stating the salary the town is willing to pay. A fair salary for the town work might induce a good municipal engineer to locate in the town to superintend municipal improvements and carry on a local

MACADAM WITH CONCRETE CURBING.

practice. A private practice of a reasonable nature would not interfere with his municipal duties.

It is strongly to be recommended that towns engage a civil engineer, rather than a street superintendent not fully qualified for the work. The average street superintendent is unable to fix grades for street pavements, sewers, sidewalks, etc., and is not sufficiently posted in technical details. The usual experience with a man not fully qualified is that, while he may get along for a certain period with apparently satisfactory results, at the end of ten years there is apt to be a good deal of bad work to do over again.

An engineer should be retained on salary, rather than by fees or commission on the cost of the work. Where an engineer is retained by salary he

can be held responsible for the oversight of all details of waterworks, sewers, street improvement, etc., both in construction and repair. An engineer, although appointed by by-law, but paid a percentage of the cost of the work, is only engaged to design and direct occasional works, as required by the council. In the latter case, the responsibility of the engineer is not sufficiently fixed, nor does it extend as it should, to the maintenance of all municipal works. An engineer retained by commission only, and employed as occasion may seem to require, is not sufficiently in touch with the work at all times to obtain the best results. It is also an important part of an engineer's services to prepare and preserve plans of municipal works for future reference, but except in the case of a permanent, salaried official, having full charge of all work at all times, this is not likely to be done. While the salary of one year may be less than the total commissions would have amounted to, yet after a term of years, the cost will be about the same in either case.

Inspection.

Works carried out under contract should always be carefully supervised by a competent inspector. It is the office of an inspector to see that the work on which he is placed is performed in accordance with the specifications and such verbal instructions as he may receive from the engineer.

Work as it ordinarily comes before the inspector may be classified under (*a*) the materials used by the contractor; (*b*) the methods of preparing these materials; and (*c*) the methods of placing these in the structure. The inspector should qualify himself for his duties in the first place by making himself thoroughly familiar with the specifications, a copy of which he should always have with him. But more than this, he should have a practical knowledge of materials and should make himself acquainted with the details of the special work under him.

He must be able to form a safe estimate of the quality of materials as they are delivered on the work, in order to reject any that are of an inferior quality or are otherwise unsuitable. Material which he rejects should be plainly marked in such a manner that it cannot be erased, and he should see that it is at once removed from the ground. If allowed to remain, there is serious possibility that all, or part, of the material so rejected will find its way into the work.

In watching the methods of preparing the materials it is necessary to see that the proper quantities are used, that dimensions are as required by the plans and specifications, that machinery and implements used are in proper working order to do good work. It is usual and preferable to allow the contractor to follow his own methods so long as these do not injure the material, and the desired results are produced. But where these methods result in defective material or improper workmanship, the contractor should be required to adopt methods that will produce results in conformity with the specifications.

In order to properly inspect the manner of construction or of putting the materials in place, the inspector should be conversant with proper methods of the various craftsmen engaged on the work. Men who persistently do careless or inferior work should be removed. The permanent removal of such men should be insisted upon. Special attention should be paid to parts of the work where careless or defective work can be covered up.

The inspector should be constantly on the work so that he may be consulted in regard to any doubtful points that may arise. The inspector should

be guided, as far as possible, by the plans and specifications, but, in case of uncertainty, should at once consult the engineer.

The inspector should arrange his work in such a way that he will cause the least inconvenience to the contractor. Arguments and disputes should be avoided, and to this end the inspector, before raising any objection, should satisfy himself fully as to his case. When he has done so, his objections and directions in regard to the matter should be given in as few words as possible, and in a spirit of firmness that will leave no room for doubt as to his intentions. At the same time complaint should be made with as little delay as possible, as the longer it is put off the greater the difficulty of rectifying the inferior work.

The position of the inspector is often one of considerable difficulty, and the man who can combine firmness with common sense and tact, who thoroughly understands his position and can maintain it with confidence, is less likely to have inferior work performed under him than is one who is known to be irresolute or who is liable to error.

SPECIFICATIONS FOR STREET CONSTRUCTION.

The following will serve as a basis upon which to frame specifications for macadam, vitrified brick and asphalt pavements. The first fourteen sec-

BRIDGE ON YONGE ST., YORK COUNTY.—STEEL SUPERSTRUCTURE ON OLD STONE ABUTMENTS. A DECK BRIDGE WITH STEEL LATTICE HAND-RAIL AND CONCRETE FLOOR; SPAN, 35 FEET; WIDTH OF ROADWAY, 18 FEET; COST, $970.

tions are applicable to all three, and each is then considered under its own heading. Details of every street undertaken will require special consideration, to be covered by such additional clauses as may be necessary. Each specification should be accompanied by plans showing the grade of the street, earth excavation or fill, width and depth of roadway, work at street intersections, drainage, curbing, alterations in sewer, waterworks or other fixtures, etc.

1. The location and approximate extent of pavement to be laid under these specifications, are as follows: Location and extent of work.

....

....

2. The space over which the roadway and curb are to be laid shall be excavated to the required depth below the elevation of the finished roadway in accordance with the plans and schedule, on file at the office of the clerk of the town of———— and forming part of these specifications. Perishable or objectionable material shall be removed to a further depth to secure a firm foundation if so required by the engineer. Such excess excavation shall be filled with gravel or other material approved by the engineer, and the bottom of the sub-grade thus obtained shall be then made thoroughly firm and solid by pounding and rolling. For all extra excavation or filling ordered by the engineer the contractor shall be entitled to the sum of 25 cents per cubic yard. Excavation and grading of roadway.

3. The earth taken from the excavation for the roadway and curb is to be used in properly grading up the boulevards and filling in any portion of the roadbed which is beneath the grade line on the proposed improvement; and the surplus earth is to be teamed from one point of the street to another as may be required in making the said boulevards where there is not sufficient earth, or in raising the elevation of lots adjacent to the street. All earth in excess of that required on the street, or streets, stone, gravel, posts, stumps, other obstacles or rubbish, shall remain the property of the town, to be removed by the contractor to such point or points as the engineer may direct; if not hauled for a distance exceeding one-half mile from the street, such removal to be without extra charge. Removal of excavated earth and rubbish.

4. The curbing, grading, draining, paving, and all work connected herewith, shall be completed to the lines and levels given by the engineer. No stakes or bench-marks placed for this purpose by the engineer shall be moved or effaced by the contractor without the permission of the engineer. Levels, stakes and bench marks.

5. The contractor is to furnish the tile and construct a four-inch field tile drain along the inside or road side of the curb line on each side of the street, as shown upon the plan on file at the office of the clerk of the town of ————. The tile are to be placed in an eight-inch trench, the bottom of the trench to be at least eighteen inches below the sub-grade of the roadway; and the tile shall be uniformly and evenly laid with a fall of not less than three inches in one hundred feet, to a proper outlet. Where it is found necessary by the engineer in reaching a suitable outlet to carry the line of tile beyond the street allowance the contractor shall receive the sum of fifty cents for each rod so laid beyond the limits of the street allowance. Tile drains for carrying surface and other water through or under the street or roadway shall be laid as indicated upon the aforesaid plans and profile, or as otherwise directed by the engineer. All tile used shall be of the best quality of clay, manufactured expressly for drain purposes, in lengths not less than one foot, and of uniform diameter throughout. All earth excavated in Tile drainage

the laying of these drains shall be returned to the trench, being thoroughly rammed and pounded in layers not exceeding one foot in thickness, and rendered perfectly firm and solid to the satisfaction of the engineer. When sewer pipe is required in place of common tile such pipe shall be furnished to the contractor by the municipality, and shall be laid in all respects to the satisfaction of the engineer.

Concrete curbs.

6. The contractor is to construct upon each side of the roadway, throughout the whole length of the street, a concrete curb, as shown upon the plans hereinbefore mentioned, such curb to be perfectly true to the line and levels given by the engineer. At each street, lane, alley, private way, etc., the curbing shall, unless otherwise directed, be returned to the sidewalk, the returns to be placed at an angle of thirty degrees with the line of the curbing. The earth at the back of the curbing is to be thoroughly rammed so as to ensure stability of the curbing. The material and workmanship used must be in conformity with the specifications and plans for curbing hereto attached.

Boulevards to be levelled and trees preserved.

7. The boulevard between the curb line and the sidewalk is to be regularly levelled off from the grade line at the top of the sidewalk to the curb or roadway as directed by the engineer. The boulevard between the sidewalk and the street limit is to be regularly and evenly graded by cutting down or filling in as may be required, so as to conform to the grade of the sidewalk, except where otherwise directed by the engineer, in order to conform to the elevation of the lawns along the said street. The boulevards are to be left smooth by raking and levelling. The contractor in doing the work must excavate or fill in around trees on the said street in a careful manner so as not to bark or injure the said trees.

Water gullies, manholes, standpipes.

8. Returns and offsets, if necessary, must be made in the line of the curb around any of the water gullies on the street. The levelling of the top of the sewer gullies, manholes, etc., and the building up or lowering of all waterworks standpipes in such manner as the engineer may direct, to suit the grade and crown of the roadbed will be done by the contractor.

Lane and street intersections.

9. All intersections of private lanes and entrances to private property are to be properly graded and paved in the boulevard by the contractor at a gradual slope from the line of the street allowance to the bottom of the gutter, and all street intersections are to be graded and paved as directed by the engineer, to conform to the finished grade and pavement of the street.

Steam roller provided.

14. A steam road roller will be provided by the town of ————, together with a man to operate it, also oil and waste, for which the contractor will pay the said town of ———— the sum of ten dollars for each and every day the roller is in use; the contractor to supply the necessary fuel, water, or other material necessary for its proper operation.

Macadam.

Broken stone surface and quality of stone.

10. The surface of the roadway is to be covered with crushed stone to a minimum depth of 10 inches in the centre and 6 inches at the curb after consolidation, to be regularly and perfectly spread over the whole of the roadbed to a depth to conform to the cross

section shown on the drawings, and proportionate to that specified for the centre and curb. The crushed stone is to be furnished by the contractor and shall be durable limestone, granite or field stone, of such quality and broken to such dimensions as may be approved by the engineer and authorized by council of the town of ————. All stone used must be free from clay, loam or earthy material. Quarry strippings will not be accepted.

Placing stone on the roadway.

11. The broken stone is to be placed on the roadway in the following manner:

(*a*) Crushed stone of a size to pass through a two and one-half inch ring is to be placed over the whole of the surface of the sub-grade to a depth, after consolidation, of 8½ inches at the centre and 4½ inches at the curb. Upon this shall be spread a coating of fine screenings, to be worked into the interstices of the stone, saturated with water and thoroughly rolled.

(*b*) Upon this shall be spread a layer of crushed stone such as will pass through a one-inch ring, to be 1½ inches in depth after consolidation, or such further depth as will bring the roadway to the line of the finished grade, this to be coated with screenings, thoroughly saturated and rolled.

Screenings to fill voids.

12. Special care must be taken to work each coating of fine screenings down into the interstices or voids in the mass of stone beneath, by thoroughly saturating and flooding with water (and by passing a harrow over the surface of the whole mass if so required by the engineer), until the engineer is satisfied that the interstices are sufficiently filled.

Manner of rolling and wetting roadway.

13. Rolling shall be commenced at the edges or curb of the road, working towards the centre, and shall be continued until the earth sub-grade and each layer in succession is firmly set to the satisfaction of the engineer, and ceases to further consolidate under the weight of the roller. The final rolling must be continued until the roadbed is perfectly consolidated and unyielding to the satisfaction of the engineer. During the whole of the rolling herein specified a sprinkling cart is to pass immediately in front of the roller, so that at all times the surface of the road will be saturated with water.

Concrete Foundation.

A layer of concrete, four inches in thickness.

14. Upon the sub-soil as graded and rolled, a foundation layer of concrete shall be laid for asphalt and vitrified brick pavements in the following manner:—It shall be composed of one part by weight of cement, of a quality approved by the engineer, and in accordance with the specifications for such elsewhere herein described; two and one-half parts by weight of clean, sharp sand, and five parts by weight of broken stone, of such a size as will pass through a two-inch ring. (Or where gravel is used the concrete shall be composed of one part of cement and seven parts of clean gravel). All concrete shall be mixed on a water-tight platform placed close to the work, by first spreading evenly a layer of sand; upon this shall be evenly spread the proportionate quantity of cement, and the two thoroughly mixed while dry. To this water shall be added, and the whole thoroughly mixed and brought to the consistency of mortar. The proportionate amount of stone shall

then be spread evenly over this mortar and thoroughly intermixed therewith. The concrete, when mixed as aforesaid, shall be immediately put in place and thoroughly pounded until it has an even surface, is perfectly and uniformly solid, and is four inches in depth over the foundation.

Vitrified Brick.

Quality of paving brick.

15. Brick shall be of the best quality of paving brick, made of shale or fire clay; re-pressed and burned for street paving purposes. They shall be of only one size and make, rectangular with straight parallel sides, and not more than 3 x 4 x 9 inches nor less than 2½ x 4 x 8½ inches. They shall be strong, tough, hard, non-absorbent, free from cracks, bunches and defects of any kind, and shall be equal in all cases to the sample submitted with the tender.

Sand cushion.

16. On the concrete foundation shall be spread a layer of clean, coarse, dry sand to such depth as may be necessary to bring the surface of the pavement after being rammed and rolled, to a proper grade. The sand cushion shall be brought to the exact form and crown by means of a template of proper shape, resting on the curbs, or with one end on the curb and the other on a scantling imbedded in the sand at the centre. The template shall be drawn forward and backward immediately in front of the brick-laying, so that the sand cushion shall be kept at the required crown. The brick shall be set on the sand bed at right angles to the curb line, except at intersecting streets, where they shall be laid in "herring-bone" or such other manner as the engineer may direct.

Joints.

17. The brick shall be laid in close contact with one another, the workmen to stand on the bricks already laid, and in no case shall the sand cushion be disturbed or walked on after having been brought to the exact grade and crown. When the bricks are laid the end joints shall be made close and compact by means of a steel bar applied at the ends next the curb. At every fourth course, or when directed, the bricks are to be closed up, and the courses straightened in a satisfactory manner. Longitudinal joints must be broken by a lap of half the length of the brick.

Trimming and cutting.

18. In trimming and cutting the bricks, proper care shall be taken not to check or fracture the part used, all joints to be at right angles to the top and sides. Nothing but whole brick shall be used except in starting or finishing a course, or in such cases as may be specially permitted by the engineer, and in no case shall less than half a block be used.

Rolling.

19. The pavement shall be swept clean with brooms and rolled with a roller weighing not less than five tons until all the brick are thoroughly imbedded in the sand and brought to a uniform, unyielding bearing, the finished surface to be smooth and even, with the required grade and crown.

Portland cement grout.

20. Unless otherwise specified, the surface of the pavement, after rolling as above, shall be made thoroughly wet and grouted with a mixture of equal parts of Canadian Portland cement and fine sharp sand, and sufficient water to run freely. The grout shall be poured over the surface of the pavement and swept into the joints with stiff brooms until no further settlement is apparent,

the grout remaining flush with the top of the bricks. A thin layer of sand shall be spread upon the pavement, the street to remain closed for such time thereafter as the engineer may direct.

Asphalt Block.

Dimensions and quality of blocks.

21. The blocks shall be of the best quality. They shall be five inches in width, twelve inches in length, and four inches in depth, and shall be composed of approved asphaltic cement and crushed granite, trap, or other equally durable stone. Blocks must be square, with sharp corners, and blocks having chipped or rounded edges, or varying from the above dimensions by one-quarter inch, may be rejected.

Cement mortar.

22. Upon the concrete foundation shall be spread a layer of Canadian Portland cement mortar, one-half inch in thickness, mixed in the proportion of one part by measure of cement to three parts of sand. The blocks shall be laid directly in the mortar, and brought to a uniform bearing and smooth top surface before the mortar has begun to set.

Laying blocks

23. The blocks will be laid by pavers standing or kneeling upon the blocks already laid. Each course will be formed of blocks of a uniform width and depth. The blocks will be laid with their length at right angles to the axis of the street; and shall be so laid that all longitudinal joints shall be broken by a lap of at least four inches. Each course of blocks will be laid against the course preceding it in such manner as to make all joints as tight as possible.

Ramming and finishing.

24. When laid, the blocks will be covered with clean, fine sand, entirely free from loam or earthy matter, perfectly dry, and screened through a screen having twenty meshes to the inch, this sand to be swept over the pavement until all joints are filled.

SPECIFICATIONS FOR CONCRETE CURB AND GUTTER.

Plans and dimensions.

(1) The curb and gutter to be constructed under these specifications consists of about —— lineal feet on the east and west side of ———— street, in the town of ————, and between ———— street and ———— street, the location on the said street to be more particularly defined by the engineer.

The combined curb and gutter shall conform to the dimensions shown upon the drawings hereto attached and forming part of these specifications.

Lines, curbs and bench-marks.

(2) All work shall be completed to the lines and levels given by the engineer. No stakes or bench-marks placed for this purpose shall be moved or effaced by the contractor without permission so to do.

Foundation of gravel, six inches deep.

(3) The curbing and gutter shall be laid upon a six-inch bed of gravel, cinders, broken stone or other material approved by the engineer, which shall be thoroughly tamped and consolidated.

A core or backing, and finishing coat.

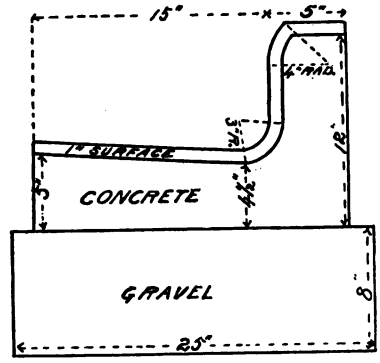
(4) The curb and gutter shall consist of a concrete core or backing, faced with a one-inch surface coat of mortar, as indicated by the drawings hereto attached.

Concrete core.

(5) The concrete core shall be composed of one part of the best quality of Portland cement, three parts of clean, sharp sand, and five parts of approved broken stone; the stone to be broken into cubical fragments not exceeding one and one-half inches, nor less than one-half inch in any direction. The cement and sand shall first be mixed dry, and until the mixture has a uniform color. Sufficient water shall be slowly added, and the mixing continued until mortar of a proper consistency is produced. The crushed stone shall then be added and thoroughly intermixed therewrth until each fragment of stone is coated with mortar. The concrete shall then be put in place and thoroughly compacted by ramming.

Surface coat cement mortar.

(6) The surface of finishing mortar, one inch in thickness, shall consist of one part by measure of Portland cement and three parts of clean, sharp sand of varying sized grain. These materials



shall first be mixed while dry and until the mixture is of a uniform color. Water shall then be slowly added until an evenly tempered and suitable mortar is obtained, when it shall at once be put in place.

Cement.

(7) All cement must be of a well and favorably known brand of Canadian Portland cement, and shall be delivered in barrels or weather-proof packages, each labelled with the name of the brand and the manufacturer. Any barrels or packages broken or torn at the time of delivery shall be rejected. Immediately on delivery it is to be stored in a dry, well-covered, and well-ventilated building, or to be otherwise protected from rain or dampness by a suitable covering.

Finishing the surface.

(8). The entire exposed surface shall be neatly faced by floating and troweling with a coat of neat cement, and finished with a dampened bristle brush, so as to give a uniform color throughout.

Work to be carried on rapidly.

(9) The work shall be carried on as rapidly as the concrete can be thoroughly rammed, and the whole curb and gutter shall be completed while in a soft and plastic state, so that it shall be monolithic when set.

Division of curb, street and lane intersections.

(10) The curb shall be divided into sections eight feet in length by such means as will insure complete separation. At street and lane intersections the curb shall be made on a curve of such radius as the engineer shall direct, with true and even joints, and shall be set and finished in the manner hereinbefore described.

Temporary forms.

(11) The temporary forms used in shaping the gutter and curb shall be set accurately and firmly in place, these to be provided by

and remain the property of the contractor. When the form is removed, the vacant space must be filled with suitable earth and thoroughly tamped to the satisfaction of the engineer.

(12) No additional allowance shall be made for round corners, off-sets for catch basins, gullies, or other obstructions, the price paid to be per lineal foot of curbing in place complete. Special construction to protect trees shall be made when deemed necessary by the engineer. Price per lineal foot.

(13) The contractor shall be bound to maintain the curb and gutter in perfect repair, free from all cracks and defects, for the term of two years from the date of completion thereof, so that at the end of such term, the work shall have given evidence of proper construction and durability, and should the contractor fail to repair or reconstruct the curb and gutter in accordance with these specifications at any time during the said term, the engineer may cause the necessary repairs to be made, retaining the cost from moneys due, or becoming due to the said contractor, or may recover the same from the contractor, or his sureties in this contract, as money paid at their request. Contractor to maintain work in perfect repair for two years from date of completion.

SPECIFICATIONS FOR CONCRETE SIDEWALKS.

(1) The location and approximate extent of artificial stone sidewalks to be laid under these specifications are as follows:— Location and extent of walks.

....

....

(2) The contractor shall remove the old plank, stone, brick, and other sidewalk from the street before the construction of the new walk shall be commenced, all such material being the property of the town, to be disposed of as the council may direct. Removal of old sidewalks.

(3) All excavated earth, stones, posts and other obstacles or rubbish shall remain the property of the town, to be removed by the contractor to such a point or points as the engineer may direct: if not hauled for a distance exceeding one-half mile, such removal to be without extra charge. Removal of excavated earth and rubbish.

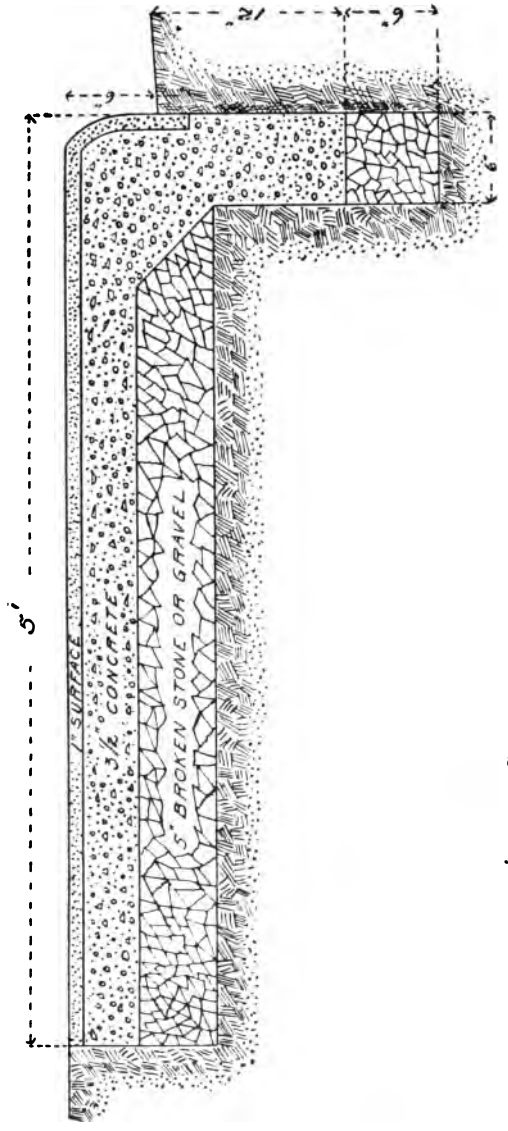
(4) The walk shall be laid to the lines and levels given by the engineer. No stakes or bench-marks placed for this purpose by the engineer shall be removed or effaced by the contractor without the permission of the engineer. Levels, stakes and bench-marks.

(5) The space over which the walk is to be laid shall be excavated to a depth of ten inches below the elevation of the finished walk, in accordance with the stakes placed by the engineer. Perishable or objectionable material shall be removed to a further depth, to secure a firm foundation, if so required by the engineer. Such excavation in excess of ten inches shall be filled with gravel or other material approved by the engineer, and the bottom of the sub-grade thus obtained shall be then made thoroughly firm and solid by pounding or rolling. For all excavation and filling ordered by the engineer in excess of ten inches below the grade of the Preliminary excavation and earthwork.

finished walk, the contractor shall be entitled to the sum of twenty-five cents per cubic yard.

A layer of gravel or broken stone six inches in thickness.

(6) Upon the sub-grade thus excavated, drained and consolidated, shall be spread a layer of clean gravel or broken stone, or lake stone, to be thoroughly wetted, rolled or pounded, and brought to an even surface. The layer of gravel or stone so placed shall



CONCRETE SIDEWALK—CROSS-SECTION.

have a thickness of six inches; and shall be uniformly not less than four inches below the elevation of the surface of the finished walk, having preference thereto.

A layer of concrete three inches in thickness.

(7) Upon the foundation thus prepared, a layer of concrete shall be laid in the following manner:—It shall be composed of one part by weight of cement, of a quality approved by the engineer, and in accordance with the specifications for such else-

where herein described; three parts by weight of clean, sharp sand and six parts by weight of broken stone, of such a size as will pass through a two-inch ring. (Or where gravel is used the concrete shall be composed of one part of cement and seven parts of clean gravel.) The concrete shall be mixed on a water-tight platform, placed close to the work, by first spreading evenly a layer of sand; upon this shall be evenly spread the proportionate quantity of cement, and the two thoroughly mixed while dry. To this water shall be added, and the whole thoroughly mixed and brought to the consistency of mortar. The proportionate amount of stone shall then be spread evenly over this mortar and thoroughly intermixed therewith. The concrete when mixed as aforesaid shall be immediately put in place and thoroughly pounded until it has an even surface, is perfectly and uniformly solid, and is three inches in depth over the foundation and within one inch of the finished surface of the walk. Slab or flag divisions, sixteen feet in area, shall be marked off, by such means as will ensure complete separation, the joints to be filled with clean sand or other approved separating material.

A layer of cement-mortar one inch in thickness

(8) Before the aforesaid layer of concrete has set, and while it is still adhesive, there shall be laid upon it a wearing surface one inch in thickness. It shall be composed of one part by measure of Portland cement, and three parts by measure of clean, sharp sand. The cement and sand shall be mixed dry, water then added to moisten sufficiently, the whole again thoroughly manipulated and mixed in a water-tight box or floor and immediately put in place. The layer shall then be thoroughly worked to a true and even surface. Over this shall be sifted a layer of Portland cement, the whole to be neatly levelled to a perfectly smooth surface and rolled with a tooth roller to make a surface that will not be slippery. This surface layer shall be cut into sections, the joints to correspond exactly with those of the first described layer of concrete, the edges of the walk to be rounded, and the whole finished in a neat and workmanlike manner.

Temporary curbs to be supplied by the contractor.

(9) Before any concrete is placed in the walk, temporary curbs of 2 x 6 pine, with edges dressed so as to be perfectly straight, shall be firmly and accurately placed along the outer edges of the walk, to be removed after the walk has hardened; these curbs to be furnished by, and remain the property of the contractor. When the curb is removed, the vacant space must be filled with good soil, and any sodding disturbed in so doing must be carefully restored.

Total thickness and slope of walk.

(10) The total thickness of the walk, including foundation layer, concrete layer, and the wearing surface, shall be uniform throughout, and shall have a slope towards the roadway of one-fourth inch to the foot, unless otherwise required by the engineer.

Cement.

(11) All Portland cement used in the work must be of some well and favorably known brand, and shall be approved by the engineer. It shall be delivered in barrels or equally tight receptacles, and must be protected from the weather by storing in a tight building or by suitable covering, the packages to be placed on boards or flooring raised above the ground. All cement rejected by the commissioner shall be conspicuously marked "Condemned," and shall be immediately removed from the site of the work. Should any cement so rejected be thereafter used in the walk, such

sections as may be required by the engineer shall be immediately torn up by the contractor, and replaced with cement of proper quality, without extra compensation. The supply of cement must be so gauged that a sufficient quantity will be kept on hand to allow ample time for testing and examination by the engineer, without delay to the work of construction; the cement to conform to the specifications for cement hereto attached.

Curb, and curb with gutter.

(12) The curb, or combined curb and gutter are to be of the form and dimensions shown upon the plan hereto attached, and the construction will, in all respects, be subject to the provisions of this specification applicable thereto. The concrete for the core or backing is to be of the same mixture provided for walks, the facing to be the same as provided for the finishing coat for walks The curb and gutter are to be separated into sections eight feet long, are to be faced with a light layer of neat cement, floated, trowelled, and worked to a proper form and uniform color.

Sand and stone.

(13) The stone and sand shall at all times be subject to the approval of the engineer, the sand to be clean, sharp and silicious.

Street crossings, lanes and private driveways.

(14) At the street crossings, lanes and private driveways the walk shall be so rounded, placed, and at such an elevation as to give a convenient passage for vehicles, to the satisfaction of the engineer. The surface layer of concrete shall be 1½ inches thick, composed of equal parts by measure of cement and sand, and marked into diamond-shaped blocks by lines crossing the walk diagonally six inches apart. The edges shall be rounded, and faced to the bottom of the concrete with cement mortar used for surfacing the walk. At all street crossings, and elsewhere, if so desired by the engineer, the edges of the walk shall be protected by a curbing of 4 x 6 cedar, placed in a permanent and durable manner, flush with the surface of the walk.

Trees, tree-spaces, gratings, areas, etc.

(15) The contractor, in doing the work, shall excavate or fill in around the trees in a careful manner, so as not to injure the said trees; and all gratings, areas, tree spaces, or other interruptions to the walk shall be regarded as continuous in the payment of the walk. The repairing or building up of area walls or other supports for gratings, shall be performed and the material supplied by the contractor, as the engineer may direct.

Laying concrete in wet or freezing weather.

(16) No concrete shall be laid in wet or freezing weather.

Prevention of injury to waterworks and other appliances.

(17) Care must at all times be taken to prevent injury to waterworks, stopcock-boxes, down pipes, door sills, steps, areas, gratings, or other appliances which may be under, project into, or pass through the walk, and the pavement shall be carefully and neatly filled around such appliances. When required by the engineer, all gratings or covers furnished the contractor shall be properly fitted into and conform to the surface of the walk.

Contractor to maintain walk for two years from date of completion.

(18) The contractor shall be bound to maintain the walks and crossings in perfect repair, free from all cracks and defects, for the term of two years from the date of completion thereof, so that at the end of such term, the walks shall have given evidence of proper construction and durability, and should the contractor fail to repair or reconstruct the walks in accordance with these specifications at any time during the said term, the engineer may cause the necessary repairs to be made, retaining the cost from moneys

due, or becoming due, to the said contractor on this or any other contract between the town and the contractor, or may recover the same from the contractor, or his sureties in this contract, as money paid at their request. The certificate of the engineer is to be final as to the necessity of repairs and amounts expended upon them.

GENERAL CONDITIONS.

Forming Part of all Specifications.

Commencing the work.

1. The work to be done under these specifications shall be commenced on such day and at such place or places as the engineer may direct. Failure so to commence without good and valid reason therefore shall be authority for the engineer to declare the contract forfeited. Nor shall the contractor commence work on any street without the written order of the engineer so to do.

Forfeiture of contract.

2. The Board of Works reserves the right to declare the contract forfeited at any time it should appear to the engineer that the work or any part thereof is being unnecessarily delayed by the contractor, or that the contractor is wilfully violating any of the conditions of the contract, or is executing the same in bad faith.

Interference with traffic.

3. Care should be taken at all times not to interfere with business or travel more than is absolutely necessary for the faithful performance of the work. The contractor shall make suitable and adequate provision for the safe and free passage of persons by or over the works, as may in the opinion of the engineer be necessary.

Care of private lawns, etc.

4. At all times during the progress of the work care must be taken not to unnecessarily injure or destroy private lawns, sidewalks, pavements, trees nor boulevards adjacent to the walk.

Removal of surplus material.

5. On the completion of the work all surplus or refuse material must be immediately removed from the street by the contractor. If not removed within forty-eight hours after notice in writing so to do from the engineer, it shall be removed by the engineer at the contractor's expense.

Liability in case of accident.

6. The contractor shall, during the progress of the work, use all proper precautions by good and sufficient barriers, red lights, or watchmen, for the prevention of accident, and he shall indemnify and save the corporation of the town of ———— from all suits and actions, and all costs and damages occasioned by the negligence or carelessness of the contractor, or his agents or employees.

Interpretation of specification.

7. The decision of the engineer shall be final in case of ambiguity of expression of the specifications or doubt as to the correct interpretation thereof.

Disorderly or incompetent employees.

8. Any disorderly or incompetent person or persons who may be employed on the work shall be removed when required by the engineer, and no person so removed shall thereafter be employed upon any portion of the work.

Material and work to be approved by engineer.

9. All materials used in the work, or any portion thereof, included under this contract, shall be subject to the inspection and approval of the engineer. The supply of each and all material or materials must be so gauged that a sufficient quantity will be kept on hand to allow ample time for testing and examination by the engineer without delay to the work of construction.

Removal of condemed work or material.

10. All material rejected by the engineer shall be immediately removed from the site of the work by the contractor. In case the contractor should refuse to remove or replace any rejected work or material within forty-eight hours after written notice, such work or material shall be removed by order of the engineer at the contractor's expense.

Failure to condem work or material not to imply acceptance.

11. Any defective work or material that may be discovered by the engineer before the final acceptance of the work or before final payment has been made, shall be removed and replaced by work and material which shall conform to the spirit of the specification; failure or neglect on the part of the engineer to condemn or reject bad or inferior work or materials shall not be construed to imply an acceptance of such work or materials.

Engineer's estimates final and conclusive.

12. It shall be understood and agreed by the parties hereto that due measurements shall be taken during the progress of the work, and the estimates of the engineer shall be final and conclusive evidence of the amount of work performed by the contractor under and by virtue of this agreement, and shall be taken as the full measure of compensation to be received by the contractor.

Payment to be made fortnightly.

13. The contractor is entitled to receive 80 per cent. of the value of any portion of the work performed under these specifications at the end of each fortnight, the amount to which the contractor is so entitled being certified by the engineer. At the expiration of sixty days after the acceptance of the work the whole of the moneys accruing to the contractor, under these specifications shall be paid, excepting such sum or sums of money as may be retained under any of the provisions herein contained, and such sums as may have been paid in the form of partial payments upon the fortnightly estimates of the engineer.

Notices to parties interested.

14. All necessary notices to waterworks, gas, electric light, telephone or telegraph officials, owners or occupants of property, or other interested parties, shall be given by the contractor.

Payment of workmen.

15. The contractor shall punctually pay the workmen who shall be employed on the work comprised in these specifications, in cash current, and not what is denominated as "store" pay. And final payment for the work shall not be made until satisfactory vouchers are furnished the engineer by the contractor showing all wages and accounts for materials and implements used in the work to have been paid.

Unforeseen obstruction, delay or hindrance.

16. All loss arising from unforeseen obstructions or difficulties encountered in the performance of the work under these specifications, or from delay or hindrance from any cause during the prosecution of the same, shall be sustained by the contractor.

Suitable appliances to be used.

17. The contractor is to use such methods and appliances for the performance of all the operations connected with the work embraced under this contract as will secure a satisfactory quality of work and a rate of progress which will secure the completion of the work within the time specified.

Assignment of contract.

18. The work to be performed under this contract, or any part thereof, or any money or orders payable under this contract, shall not be assigned nor sub-let by the contractor, without the pre-sanction of the council of the town of ————. No sub-contract shall under any circumstances relieve the contractor of his liabilities and obligations under this contract. Should any sub-contractor fail to perform the work undertaken by him in a satisfactory manner, and should this provision be violated, the council of the town of ———— may, at their option, end and terminate such contract.

Change in plans and specifications.

19. Should any changes or alterations in these specifications or plans in connection therewith, be, at any time, deemed necessary by the engineer, he shall have authority to make such changes or alterations, and, unless otherwise herein provided for, an amount proportionate to the prices contained in the tender upon which the contract was awared shall be added to or deducted from the original amount of the contract.

Contractor or his agent to be on work.

20. The contractor or his duly authorized agent or foreman shall at all times while work is in progress be on the ground, and instruction given by the engineer to such agent or foreman shall be of the same effect as if given to the contractor.

Engineer defined.

21. The word engineer, where and whenever used herein, refers to the engineer of the town of ———— or his authorized assistants, or other person appointed by the council of the town of ———— to have charge and oversight of the work.

Contractor defined.

The word contractor, wherever used herein, refers to the party or parties contracting to perform the work to be done under this contract, or the legal representatives or representative of such party or parties.

Tender to be accompanied by certified cheque.

22. Each tender must be accompanied by a certified cheque for the sum of $100 as a guarantee of good faith on the part of the person tendering, all such cheques to be retained in the possession of the town treasurer until the contract and bond for the performance of the work are signed and filed with the engineer.

Bond for $1,000.

23. Before the contract shall be signed or the work commenced the contractor shall furnish a bond for the sum of $1,000 for the satisfactory completion of the work, signed by two responsible sureties and approved by the chairman of the Board of Works.

Right to reject tenders.

24. The right to reject any or all tenders is reserved by the town of ————, and the lowest or other tender is not necessarily accepted.

Form of tender.

25. Tenders for the work under these specifications must be made on the forms for this purpose, which may be had on application to the engineer.

Receiving tenders.

26. Sealed tenders, endorsed ..... will be received by the engineer, up to noon, the .....day of ..... next.

Ontario. Dept. of Highways.
Report.